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FORAGE WEIGHT INVENTORIES ON SOUTHERN FOREST RANGES

R. S. Campbell and John T. Cassady
Southern Forest Experiment Station

A first step in the management of a forest range is to inventory the forage--to determine the kind and amount of plants edible to livestock on various parts of the range. This information is needed to plan the proper number and distribution of animals and the season of grazing. The forage inventory method described here has been used on several experimental forests of the Southern Forest Experiment Station since 1944, and on national forests in the Gulf States and Arkansas since 1951.

The method may be illustrated by the situation of a farmer who has 10 tons of hay. He reckons that if he allows 20 pounds of hay per cow per day he can winter about 11 cows for 3 months. The farmer's problem is fairly easy, for the hay is cut and stored in the stack or in the barn. On the range, cattle do the harvesting, and the stockman must determine (that is, estimate by sampling) the amount of green grass on an area and then calculate the approximate number of cattle the area will support during the grazing season.

As described here, forage inventories for cattle range management will determine only the amount of green grass. On longleaf pine forest ranges in central Louisiana and south Mississippi, grass makes up about 95 percent of the cattle diet in spring, summer, and fall. Browse and weeds (forbs) contribute so little that it is unnecessary to sample them. On some livestock ranges, and especially on deer ranges, edible portions of weeds and browse are of real importance and should be included in the inventory.

For spring-summer-fall ranges, it is usually best to make the inventory in July, after the main grass growth is complete but before leaves begin to toughen and flower stalks become abundant. Usually about 70 percent of the year's growth will have been made by this time. However, on ranges grazed mainly during one season, such as winter or spring, the inventory should be timed to measure forage production during that season.

Relative forage production during the year of the inventory must be considered in applying the results over a period of years. In central Louisiana, a drought year produced 40 percent less range forage than

average, while a wet year produced 42 percent more than average (5) 1/. Annual spot samples should be taken to determine whether the year of inventory is above or below average in forage production. Also, the range should be inspected each year to show whether utilization is measurably above or below proper use. These check-ups will help to determine if adjustments are needed in application of the forage inventory data.

Basic Steps in Forage Inventory

The basic steps for making a range forage inventory are described immediately below. Detailed directions for carrying out some of the steps, as well as shortcuts to some of the field and office work, will be discussed later.

1. A sample plot 3.1 feet square is a convenient size for use with the abundant grass on southern ranges (2), because of ease of conversion to pounds per acre. The number of plots to be taken will depend on the degree of accuracy desired. Plots are taken in groups of 3 at systematically selected sampling points.

2. The green grass or current season's growth is clipped and weighed in grams per plot. With training, the examiner may estimate grass weight on the stalk with reasonable accuracy.

3. A few samples of the grass are saved and dried in order to convert the plot weights to an air-dry basis (similar to hay).

4. The air-dry weight of green grass in grams per plot is multiplied by 10 to convert to pounds per acre.

5. "Usable grass" is then calculated. On most southern range types, about 60 percent of the annual growth of native grasses on pine forest ranges should be left ungrazed in order to protect the plants and the soil. Therefore, under proper range use, only 40 percent of the grass is available for grazing in most types.

6. The "usable grass" per acre is multiplied by the number of acres in the range unit to obtain the pounds of usable grass (air-dry) or "hay" available under approximately proper use.

1/ Underscored numbers in parentheses refer to Literature Cited, page 15.

7. The total usable grass in the range unit is divided by 600 (20 pounds per cow per day times 30 days) to obtain the number of cow-months of grazing.

8. The total cow-months are divided by the number of months in the grazing season to determine the number of cows to be grazed.

Details of Field and Office Procedure

Preliminary Office Work

Inventory map.--Prepare for field use a forest range type map of the range unit to be inventoried (fig. 1). A convenient scale is 2 inches to the mile. Show main drainages, survey corners, fences, and roads for control. Outline with penciled dots each forest range type that is to be sampled. For practical purposes, small types of only a few acres should be lumped with larger adjacent types unless very high forage values are involved, as in the carpetgrass type. See Appendix I for suggested list of types to be recognized and sampled separately. Compute and record on the map the acreage in each type.

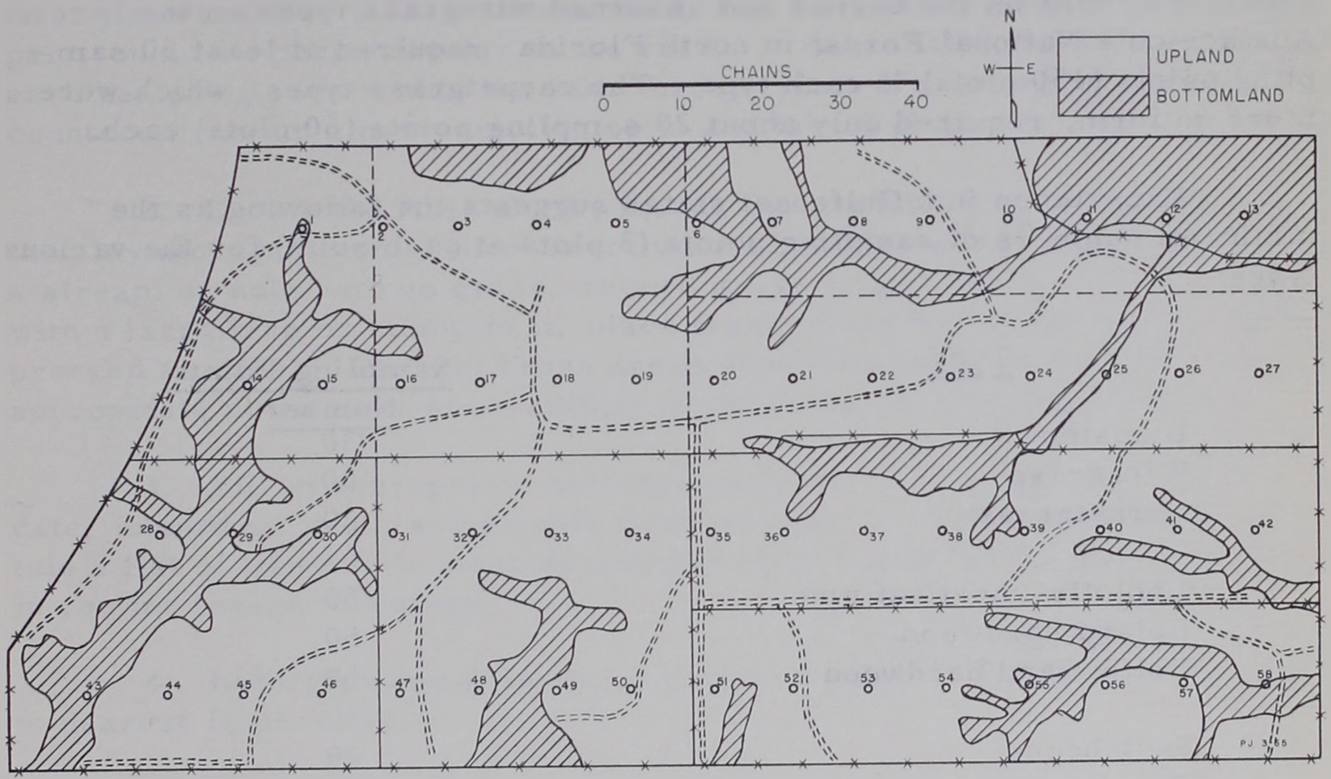

Figure 1.--Example of forest range type map of 1,200-acre area, showing sampling grid for forage inventory.

Sampling points. --Lay out tentative sampling points and number them on the map, systematically covering the entire grazing unit. Where a car is to be used in making the inventory, care must be taken to provide for sampling across the drainages rather than to take plots only on ridges or close to roads and main livestock trails.

In forage inventories, it is desirable to come within the limits of 20 percent accuracy (two standard errors), which is generally accepted as adequate in timber cruising for management plans on national forests.

Where sampling is on a grid, as in figure 1, types may be disregarded in summarizing the data, unless the type breakdown is needed for management or research purposes. Indications are that with systematic sampling, and where type breakdowns are not desired, a minimum of 65 sampling points (195 plots) are needed to sample any range unit (regardless of size) that has more than one broad type. For range units larger than 8 sections, however, a minimum of 8 sampling points per section should be taken.

Where sampling is mostly from roads (i.e., not systematic), the sampling should be planned by types. For example, to keep within 2 standard errors on the burned and unburned wiregrass types on the Apalachicola National Forest in north Florida required at least 50 sampling points (150 plots) in each type. The carpetgrass types, which were more uniform, required only about 20 sampling points (60 plots) each.

Experience in 5 Gulfcoast states suggests the following as the minimum numbers of sampling points (3 plots at each point) for the various types:

Type	Sampling Points Number
Bluestem	30
Wiregrass	50
Carpetgrass	20
Loblolly-shortleaf pine	50
Upland hardwood	50
Bottomland hardwood	50
Switchcane	20
Brush	50
Swamp	50

Equipment. --Here is a check list of equipment needed for field work:

1. Transportation
2. Plot frame, 3.1 feet square, made of welding rod or heavy wire
3. Spring balances, 500 gram
4. Sheep shears
5. Paper sacks, 16-pound kraft quality
6. Map, for control in inventory
7. Record forms and holder
8. Pencils, with erasers
9. Forest Service compass and Jake stick
10. Water
11. Lunch
12. Back packsack

Field Procedure

A two-man crew is recommended, but the inventory can be made efficiently by one man working alone.

1. Take three plots at each sampling point. The three plot values will be recorded on a single form. If travel is cross-country, then plots may be 1/4 chain apart on line. If travel is by car along roads, then the first plot should be 2 chains from road, and the other 2 plots 1 chain apart, on a line perpendicular to the road. It is best to keep the 3 plots of each sampling point within the same broad type. If a new type is encountered, set up a new sampling point and take 3 plots.

2. Locate the first plot by pacing the predetermined distance, then lay plot frame on ground directly ahead of last pace. If plot lands in a stream or hole with no grass, record grass weight as 0. If plot falls with a large tree or stump in it, place frame close beside the object and proceed as usual. Plots in brush areas should be taken as they fall, with appropriate notes as to accessibility of the forage to grazing animals.

3. Fill in appropriate headings on form: cover type, location, date, examiner, etc.; see sample form on page 6. The headings constitute a list of items to be considered, and need not be filled out completely in routine forage inventory.

4. Note previous grazing, if any, and record estimated utilization to nearest 10 percent.

Field crews should train themselves to determine utilization by the standard ocular-estimate-by-plot method developed by Pechanec and Pickford (8). In training, simulate grazing on an ungrazed plot by clipping and retaining the plant material removed. Estimate the percent-

RANGE FORAGE WEIGHT INVENTORY

Forest Apalachicola District Wakulla
Allotment Simmons Date July 29, 1952
Examiner Stradt-Bryan Sampling point No. 26
Location see map
Forest type slash pine Age ____ Density ____
Forage type wiregrass
Main species Three-awn, muhly, panicum
Grazing: Animals cattle Intensity moderate
Burning Area burned Jan., 1951
Soil and condition sandy loam
Wildlife ____

	Plots A	B	C	Total
Clipped	✓			
Estimated		✓	✓	
Grasses: Green wt. (grams)	75	90	45	X
Utilization (%)	15	10	20	X
Total production (grams)	88	100	56	244

Weeds ____
Browse ____
Litter ____
Grass: wet ____ damp ____ dry ✓

Remarks: Area unburned in current year. Very dry season.

(Form to be half letter size)

age weight removed. Then clip the remainder of the herbage, weigh both parts, calculate the actual percent utilization, and note the error of the original estimate. Training should continue until utilization can be determined within 10 percent.

Below is a descriptive utilization scale for approximating utilization percentage on bluestem grasses. The scale must, of course, be tempered according to time of year and general productivity of the grass growth in the particular year.

Description	Utilization Percent
Utilization perceptible but very patchy, leaf tips bitten off occasional grass tufts.	10
Utilization obvious but still patchy; i. e., leaf tips bitten off 1/4 to 1/2 of grass tufts.	20
Leaf tips bitten off 1/2 to 3/4 of grass tufts, but many tufts or patches still ungrazed.	30
Leaf tips bitten off more than 3/4 of grass tufts, occasional tufts or patches ungrazed, considerable nuzzling for new green growth at base of tufts on unburned range.	40
Leaf tips bitten off nearly all grass tufts, average stubble about 4 to 5 inches high. Some evidence of trampling.	50
Nearly all grasses closely grazed, especially on burned range. Average stubble only 1 to 3 inches high. Trampling.	60-95

When a forage weight inventory is made in midsummer on a range that has been grazed for the preceding 3 or 4 months, some of the utilization will be obscured by subsequent regrowth of the grass. Therefore, if any utilization can be detected in midsummer, it represents at least 10 percent utilization of the main forage grasses.

5. Remove litter and last year's grass from plot by gleaning and separating it with fingers from the current or green grass. The inventory measures only the current year's grass production, some of which may be cured or dry.

6. Clip remaining grass as close as possible to the ground, place in paper sack, and weigh in grams. Deduct tare for sack and record net green weight on form. If any old leaves, needles, or previous years' grass growth remain, pick them out before weighing. When weeds and browse are included in the inventory, clip palatable weeds and weigh separately from grass. Strip leaves and tender twigs from palatable browse plants up to 4-1/2 feet above ground and weigh separately. Proper-use factors for these kinds of plants are at present considered to be about 40 percent.

7. Proceed to next sampling point and repeat; use a new form at each sampling point.

8. On the forms, note any range conditions that may be useful in determining good management, such as livestock concentrations or ungrazed areas, extraordinary feeding habits, signs of deer, areas inaccessible to livestock or too distant from water, or recently burned areas.

9. Save samples of green grass (100 to 200 grams) during first, fourth, and last hour of the work day for dry-weight determination. As each sample is taken, record exact green weight, date, time of day, and plot number or location on the paper sack. Three such green grass samples for each main type are ordinarily sufficient. Take all samples to office for drying. If some of the plots are taken when grass is wet with dew or rain, use one of the following special procedures:

a. Moisture classification of plots. Classify each plot into one of three broad categories, and record the classification:
(1) wet, when droplets of water still cling to the leaves,
(2) damp, when there are no drops, but a thin film of moisture, damp to the touch, remains,
(3) dry, when no moisture can be felt on the leaves.

It is necessary to save a sample of grass in each moisture class.

b. Ocular estimate of grass weight. After some experience in clipping and weighing grass on plots, the examiner can train himself to estimate grass weight within about 10 percent of the actual weight. If clipping is interrupted by a brief shower, the worker may continue after the rain by estimating the weight of green grass without the surface moisture. When the leaves no longer feel moist, he should resume the standard method of clipping and weighing the grass.

For accurate research work, the wet grass on each plot can be clipped, weighed, and all of it kept and air-dried at the office. Weighing will then give the exact air-dry weight in grams per plot.

Determining Air-dry Percentages of Grass

Air-dry the grass samples. Keep samples in original sacks and avoid loss of grass or mixing between samples. After about 10 days, weigh a few samples and record weights on sacks. About three days later, repeat on same samples. If there is no appreciable change, weigh all samples and record air-dry weight on each original sack. A fan blowing over the sacks (with tops open) will hasten drying time to less than a week. Be sure to subtract tare and record net weight for both "green" and air-dry weights. Tare weight of small sacks may be determined by weighing 10 empty sacks together and dividing by 10.

Group the data for each type or moisture classification and calculate average air-dry percentages to nearest 1 percent.

$$\frac{\text{Air-dry weight} \times 100}{\text{Green weight}} = \text{air-dry percent}$$

For example, if total air-dry weight of 3 samples is 300 grams, and total green weight is 650 grams, then

300 x 100/650 = 46 percent air-dry.

Final Office Calculation

1. Correct grass production for utilization on each plot in space provided on inventory form, using table on page 18. For example, if actual weight of grass on plot is 40 grams, and utilization is 20 percent, then calculated total grass production is 50 grams.

The values in the table were calculated as follows:

$$\frac{\text{Grams of grass, green weight}}{\text{Percent not grazed (decimal)}} = \text{Total grass production}$$

Using the same example as above:

40/0.8 = 50 grams

Percent not grazed is 100 minus utilization percentage or 100 - 20% utilization = 80% ungrazed (decimal value = 0.8).

2. For each sampling point, record total grass production in grams (green weight) by adding together the three plots.

3. Sort field record sheets by types, conditions, or other classifications to which identical air-dry weight percentages and proper-use factors may be applied.

4. Determine total green weight of grass in grams for all plots in type or other classification: add together the total production from each field form.

5. Calculate for type or other classification the average green weight of grass in grams per plot: divide total from No. 4 above, by number of plots. Remember that there are 3 plots per field sheet.

6. Calculate for each type or other classification the average air-dry weight of grass in grams per plot: multiply average green weight per plot by appropriate air-dry percentage as previously determined. When this has been done, the various classifications may be combined by types.

7. Determine average air-dry grass for each type in pounds per acre: multiply average air-dry weight per plot in grams by 10 to obtain pounds per acre.

8. Determine average usable grass in pounds per acre: multiply average air-dry grass (pounds per acre) by appropriate proper-use factor (40 percent for most types).

9. Calculate total usable grass in type: multiply average usable grass (pounds per acre) by number of acres in type.

10. Add all types to obtain total pounds of usable air-dry grass (hay) in entire range unit being inventoried.

11. Calculate estimated grazing capacity in cow months of entire range unit: divide total pounds of usable air-dry grass by 600 (pounds required per cow per month).

12. Determine rate of stocking or grazing capacity for the range unit: divide number of cow months of feed by number of months in approved grazing season (number of cows for the season grazed).

An example of field plot records and computations is shown in the field sheet, page 6. Examples of final office procedure for several types are shown in figure 2. For research purposes, more detailed plot records and calculations may be made as needed.

Range forage inventory. Simmons Pasture, east allotment, Wakulla Ranger District, Apalachicola National Forest. July 28-30, 1952.

Item	Wiregrass		Carpetgrass		Brush	Swamp	Total or average
	Unburned	Burned	Woodland	Roads and headquarters			
Grass on plots							
Green weight (grams)	33,613	7,544	582	2,642	60	1,764	
Plots (number)	447	95	13	10	77	49	691
Average per plot (grams)	75.2	79.4	44.8	264.2	.8	36.0	
Air-dry (percent)	60	50	40	40	50	30	
Air-dry weight per plot (grams)	45.1	39.7	17.9	105.7	.4	10.8	
Air-dry grass per acre (pounds)	451	397	179	1,057	4	108	
Proper-use factor (percent)	10	40	100	100	10	60	
Usable grass per acre (pounds)	45	159	179	1,057	.4	65	
Acres in type	9,976	2,100	600	100	1,000	7,485	21,261
Total usable grass (pounds)	448,920	333,900	107,400	105,700	400	486,525	1,482,845
Grazing capacity							
Cow-months (grass ÷ 600)	748	556	179	176	1	811	2,471
Cows yearlong (cow months ÷ 12)	62	46	15	15	...	68	206
Acres per cow yearlong	161	46	40	7	...	110	103
Cows for 8-month season (Cow months ÷ 8)	94	70	22	22	...	101	309
Acres per cow, 8-month season	106	30	27	5	...	74	69

Figure 2. --Example of summary work sheet.

Shortcut Methods

For speeding up the forage inventory or for quick approximation of grazing capacity, various shortcuts may be employed, although they may involve some loss in accuracy where the assumed air-dry weight of 50 percent differs from the actual air-dry weight.

The first shortcut method can be used in types where the proper-use factor is about 40 percent. The plots are inventoried in the field as

in the standard method but grazing capacity is estimated from the green weight of the grasses. The shortcut calculation for the burned wiregrass type illustrated in figure 2 would be as follows:

Grass on plots	
Total green weight (grams)	7,544
Number of plots	95
Average grams per plot	79.4
Pounds of green grass per acre	794
Acres in type	2,100
Total green grass, pounds	1,667,400
Grazing capacity	
Cow months (green grass ÷ 3,000) 2/	556
Acres per cow month (2,100 ÷ 556)	3.8
Cows, 8-month season (cow months ÷ 8)	70
Acres per cow, 8 month-season	30

The second shortcut method gives a quick approximation of grazing capacity for a given type or area. Several plots should be inventoried, and the average green weight of grass per acre calculated. Then the approximate number of acres required per cow month can be read off from table 1.

The rough approximations of grazing capacity in table 1 are based on the following formula:

$$\frac{\text{Green weight of grass per cow month}}{\text{Green weight of grass per acre}} = \text{acres per cow month}$$

Example:

$$\frac{3,000 \text{ lbs.}}{250 \text{ lbs.}} = 12.0 \text{ acres per cow month}$$

Table 1 may be applied directly for bluestem and burned wiregrass types. The inventory on the Apalachicola National Forest indicated that in other types differences in air-dry weights and proper-use factors (see fig. 2) may necessitate certain adjustments:

2/ This provides 3,000 pounds of green grass per month, or 100 pounds per day. A cow would utilize about 40 percent of it, or 40 pounds per day.

Wiregrass, unburned, multiply acreages in table by 3.5.
Carpetgrass, divide acreages in table by 2.
Swamp, add 10 percent to acreages in table.

Table 1.--Approximate grazing capacity in relation to amount of grass per acre (green weight)

Grass per acre (pounds)	Acres per cow month	Grass per acre (pounds)	Acres per cow month
100	30.0	800	3.75
120	25.0	833	3.6
150	20.0	882	3.4
171	17.5	938	3.2
200	15.0	1,000	3.0
214	14.0	1,034	2.9
231	13.0	1,071	2.8
240	12.5	1,111	2.7
		1,154	2.6
250	12.0		
261	11.5	1,200	2.5
273	11.0	1,250	2.4
286	10.5	1,304	2.3
		1,364	2.2
300	10.0	1,429	2.1
316	9.5		
333	9.0	1,500	2.0
353	8.5	1,579	1.9
375	8.0	1,667	1.8
		1,765	1.7
400	7.5	1,875	1.6
429	7.0		
462	6.5	2,000	1.5
500	6.0	2,143	1.4
545	5.5	2,308	1.3
		2,500	1.2
600	5.0	2,727	1.1
632	4.75		
667	4.50	3,000	1.0
706	4.25		
750	4.00		

APPENDIX I

Broad Forest Range Types

In the upland forest types, three main grass subtypes may be recognized:

Bluestem: proper-use factor 40 percent.

Wiregrass: proper-use factor about 10 percent if unburned, 40 percent if burned during preceding winter or spring.

Carpetgrass: because of its ability to withstand repeated close grazing and to make regrowth, this type may be credited with 100 percent proper-use factor for current forage production.

The upland forest range types usually recognized are as follows:

Grassland: heavily cutover forest land with trees absent or very scattered. Usually clear-cut and non-restocking longleaf pine stumpland.

Open forest: heavily cut over, and partially restocked. Trees prominent, but not sufficiently dense to reduce grass cover conspicuously.

Longleaf pine: second-growth or planted longleaf pine with more than 300 pine and hardwood trees per acre; enough litter to reduce grass cover distinctly.

Slash pine: similar to longleaf pine, but usually with better timber stocking and frequently with more underbrush and less grass.

Upland hardwood: good upland hardwoods or scrub oaks, similar to pine types but with very few or no pine trees.

Loblolly-shortleaf pine-hardwood: many variations, but generally with less grass than longleaf and slash pine types. May be separated into open and heavily wooded if types are sufficiently distinct.

Brush: dense underbrush, such as ti-ti or gallberry, usually with very low grass production.

In the bottomland forest types, the principal forage species are lush sedges, rushes, weeds, and wetland grasses, especially panicums. A proper-use factor of 60 percent may be applied in areas that are accessible during dry periods when cattle can get into the bottomlands to graze.

The bottomland types are as follows:

Bottomland hardwood: creek bottoms and alluvial soils where bottomland hardwoods predominate. Make separate subtype for switchcane areas.

Swamp: poorly drained bottomland and swamp sites.

APPENDIX II

Total Grass Production on Grazed Plots, Calculated From Weight Measurements and Estimated Utilization

Actual weight of grass on plot (grams)	Utilization percent																		
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
	Calculated total grass production--grams																		
5	5	6	6	6	7	7	8	8	9	10	11	12	14	17	20	25	33	50	100
10	11	11	12	12	13	14	15	17	18	20	22	25	29	33	40	50	67	100	200
15	16	17	18	19	20	21	23	25	27	30	33	38	43	50	60	75	100	150	300
20	21	22	24	25	27	29	31	33	36	40	44	50	57	67	80	100	133	200	400
25	26	28	29	31	33	36	38	42	45	50	56	62	71	83	100	125	167	250	500
30	32	33	35	38	40	43	46	50	55	60	67	75	86	100	120	150	200	300	600
35	37	39	41	44	47	50	54	58	64	70	78	88	100	117	140	175	233	350	700
40	42	44	47	50	53	57	62	67	73	80	89	100	114	133	160	200	267	400	800
45	47	50	53	56	60	64	69	75	82	90	100	112	129	150	180	225	300	450	900
50	53	56	59	62	67	71	77	83	91	100	111	125	143	167	200	250	333	500	
55	58	61	65	69	73	79	85	92	100	110	122	138	157	183	220	275	367	550	
60	63	67	71	75	80	86	92	100	109	120	133	150	171	200	240	300	400	600	
65	68	72	76	81	87	93	100	108	118	130	144	162	186	217	260	325	433	650	
70	74	78	82	88	93	100	108	117	127	140	156	175	200	233	280	350	467	700	
75	79	83	88	94	100	107	115	125	136	150	167	188	214	250	300	375	500	750	
80	84	89	94	100	107	114	123	133	145	160	178	200	229	267	320	400	533	800	
85	89	94	100	106	113	121	131	142	155	170	189	212	243	283	340	425	567	850	
90	95	100	106	112	120	129	138	150	164	180	200	225	257	300	360	450	600	900	
95	100	106	112	119	127	136	146	158	173	190	211	238	271	317	380	475	633	950	
100	105	111	118	125	133	143	154	167	182	200	222	250	286	333	400	500	667		
105	111	117	123	131	140	150	161	175	191	210	233	262	300	350	420	525	700		
110	116	122	129	138	147	157	169	183	200	220	244	275	314	367	440	550	733		
115	121	128	135	144	153	164	177	192	209	230	256	288	329	383	460	575	767		
120	126	133	141	150	160	171	185	200	218	240	267	300	343	400	480	600	800		
125	132	139	147	156	167	179	192	208	227	250	278	312	357	417	500	625	833		
130	137	144	153	162	173	186	200	217	236	260	289	325	371	433	520	650	867		
135	142	150	159	169	180	193	208	225	245	270	300	338	386	450	540	675	900		
140	147	156	163	175	187	200	215	233	255	280	311	350	400	467	560	700	933		
145	153	161	171	181	193	207	223	242	264	290	322	362	414	483	580	725	967		
150	158	167	176	188	200	214	231	250	273	300	333	375	429	500	600	750			
155	163	172	182	194	207	221	238	258	282	310	344	388	443	517	620	775			
160	168	178	188	200	213	228	246	267	291	320	356	400	457	533	640	800			
165	174	183	194	206	220	236	254	275	300	330	367	412	471	550	660	825			
170	179	189	200	212	227	243	261	283	309	340	378	425	486	567	680	850			
175	184	194	206	219	233	250	269	292	318	350	389	438	500	583	700	875			
180	189	200	212	225	240	257	277	300	327	360	400	450	514	600	720	900			
185	195	206	218	231	247	264	285	308	336	370	411	462	529	617	740	925			
190	200	211	223	238	253	271	292	317	345	380	422	475	543	633	760	950			
195	205	217	229	244	260	278	300	325	355	390	433	488	557	650	780	975			
200	211	222	235	250	267	286	308	333	364	400	444	500	571	667	800				